

# European Perspective on Geostationary Microwave Sounding

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## Abstract

The first European undertaking in space meteorology was Meteosat, launched in the geostationary orbit on 23 November 1977. Since then, seven flight models have been placed in orbit, Meteosat-7 due to be in use up to about 2004. Meteosat Second Generation (MSG) has been launched on 28 August 2002. The MSG programme will provide four flight models, to be in use up to about 2017. Planning for an MSG-follow-on programme, possibly Meteosat Third Generation, has already initiated. After a one-year preparatory work, the EUMETSAT 1<sup>st</sup> Post-MSG User Consultation Workshop took place on 13-15 November 2001. Follow-on industrial studies are now being organised in cooperation with ESA.

A number of user requirements clearly call for an improved VIS/IR imager, which is certainly feasible with current technology. Also it seems feasible to meet a number of requirements calling for a high-spectral-resolution IR sounder. A major requirement, to have good wind profiles, can only indirectly be addressed by improving the imagery and sounding missions. Another major requirement is for frequent observation of precipitation. This requirement can partially be addressed by improving the VIR/IR imagery and the IR sounding missions, but clearly calls for MW radiometry. In addition, there is a strong requirement to have frequent temperature/humidity sounding in overcast areas, which also calls for MW radiometry. However, it is currently felt that affordability and programmatic constraints are too tight to enable a MW radiometer being baselined for an operational Meteosat Third Generation proper.

Studies on MW sounding from geostationary orbit have therefore started as a side-activity to post-MSG planning. A project named GOMAS (*Geostationary Observatory for Microwave Atmospheric Sounding*) has been defined (in cooperation with US partners) and proposed to ESA as an Earth Explorer Opportunity Mission. The proposal was not selected because of incompatibility between the technology readiness and the schedule constraint, but ESA has accepted a recommendation to pursue some technological activity in the field. Meanwhile, the Italian Space Agency (ASI) has approved a 3-year study aimed at preparing a proposal for a demonstration mission to be implemented as a national or multi-lateral programme. Convergence between GOMAS and the U.S. activity on GEM (Geostationary Microwave Observatory) is being pursued.

The principle of GEM and GOMAS is to infer precipitation from absorption bands rather than atmospheric windows. Oxygen and water vapour bands at different frequencies are used to retrieve temperature and humidity profiles. The retrievals at different frequencies are differently affected by liquid and ice water, drop size and shape, and precipitation; therefore, in principle, simultaneous retrieval of temperature/humidity profile, cloud ice/liquid water columnar content or gross profile and precipitation is possible. Being in absorption bands, the observation is equally available over sea and land.

European requirements for GOMAS and U.S. requirements for GEM are slightly different. Better s.s.p. resolutions are required to compensate for the relatively high latitudes of Europe (the baseline antenna diameters are 3-m for GOMAS, 2-m for GEM). The variability of precipitation types is higher for Europe, since non-convective rain and snowfall are dominant and convective rain also is well represented: therefore, the spectral range of the radiometer must be such as to ensure widest applicability. All-weather temperature and humidity profiles are important over (the generally cloudy)

Europe: therefore, the number of channels, their bandwidths and the radiometric accuracy must be conveniently stringent. The final outcome is that, whereas GEM could be attempted to be compatible with a large multi-purpose satellite of a GOES+ series, GOMAS is more likely to require a free-flyer.

The current preliminary concept of GOMAS, scaled from GEM and based on the latest performances in MW and Sub-mm technology, will be presented. A 3-m antenna and five bands are considered (54, 118, 183, 380 and 425 GHz), for a total of about 40 channels. The radiometric performance needed for profiling each 15 min is achieved if the scanned area is limited to about 1/12 of the Earth disk. If USA/Europe cooperation materialises, the demonstration mission would be organised so as to move the scanned area towards any part of the disk and periodically migrate the satellite s.s.p. between America and Europe. The mass estimate of a GOMAS free-flyer is 860 kg at launch, 430 kg “dry”. The data rate is 128 kbps, compatible with direct reception at low-cost MSG local stations. The satellite would allow simultaneous retrieval of:

- temperature profile with resolution  $\approx 30$  km at s.s.p.
- humidity profile with resolution  $\approx 20$  km at s.s.p.
- cloud liquid/ice water columnar content and gross profile with resolution  $\approx 20$  km at s.s.p.
- precipitation rate with resolution  $\approx 10$  km at s.s.p.

***each 15 minutes, over  $\sim 1/12$  of the disk covering sea and land.***